

**BENTHIC MACROINVERTEBRATE SURVEYS
CANE CREEK AND HUDGENS CREEK
PUTNAM COUNTY, TENNESSEE
APRIL 2017**



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EXECUTIVE SUMMARY

Pennington and Associates, Inc. conducted studies of the benthic macroinvertebrate fauna on April 12, 2017 in Cane Creek just downstream of I-40 and Hudgens Creek just downstream of South Lovelady Road, both in Putnam County, Tennessee. Physical characteristics were measured and included width, depth, flow, substrate, canopy and habitat. Cane Creek had a flow of approximately 6.46 cfs while that in Hudgens Creek was near 19.3 cfs. The substrate in Cane Creek *was* mostly gravel, silt and sand while that in Hudgens Creek was dominated by bedrock. Habitat scored as not impaired at both locations. Water quality parameters taken included pH, conductivity, temperature, dissolved oxygen and turbidity. PH was slightly alkaline in both creeks (7.60 in Cane Creek and 7.87 in Hudgens Creek). Conductivity was near 200 $\mu\text{s}/\text{cm}$ in both creeks (201.9 $\mu\text{s}/\text{cm}$ in Cane Creek and 214.0 $\mu\text{s}/\text{cm}$ in Hudgens Creek) while dissolved oxygen ranged from 8.41 mg/l in Cane Creek to 9.29 mg/l in Hudgens Creek. Temperature was 14.6 °C in Cane Creek and 14.4°C in Hudgens Creek. The water was slightly turbid in Cane Creek (6.71 ntu's) when compared to Hudgens Creek (3.77ntu's). A minimum of 34 benthic macroinvertebrate genera were taken in Cane Creek while 37 were found in Hudgens Creek. Non-biting midges were dominant in the benthic fauna. Because of the high numbers of non-biting midges the benthic macroinvertebrate fauna in Cane Creek had a TMI score of 18 out of a possible 42 which is short of the 32 score required to pass biocriteria. The benthic macroinvertebrate fauna in Hudgens Creek produced a TMI score of 34 which is considered passing biocriteria.

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INTRODUCTION

Pennington and Associates, Inc. (PAI) conducted a survey of the benthic macroinvertebrate fauna in Cane Creek and Hudgens Creek, Putnam County, Tennessee on April 12, 2017. The survey were conducted to satisfy NPDES permit requirements for storm water management. The benthic macroinvertebrate community at each location was assessed and scored using metrics developed by the State of Tennessee Department of Conservation (2011).

BACKGROUND

In an aquatic impact assessment, attention usually focuses on benthic macroinvertebrate species because they are more indicative of the relative health of a stream. Macroinvertebrates occur in all aquatic habitats, are less mobile than other groups of aquatic organisms such as fish, are easily collected, and most have relatively long periods of development in the aquatic environment. Thus, benthic macroinvertebrate species can be used to indicate deleterious events that have occurred in an aquatic system during any stage of their development. As found in other similar studies, the alteration of the physical and/or chemical norms of an aquatic environment has the potential to influence all organisms residing in that environment (Goodnight 1973). A benthic macroinvertebrate community represented by numerous species with no particular numerical domination evident in the population is usually indicative of an unstressed environment (Weber 1973). Conversely, a benthic macroinvertebrate community composed of a few species with large numbers of individuals typifies a stressed community from which intolerant species have been reduced, or eliminated by a pollutant or substrate change. The populations of tolerant species expand due to reduced competition or increased resources, or both. The often-dramatic shifts in the benthic macroinvertebrate community, which can occur under stressed conditions, are due to the varying sensitivities of the different macroinvertebrate species. Mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera), commonly referred to as EPT species, are generally less tolerant of most types of pollution and are considered intolerant or sensitive species, whereas many flies (Diptera) and worms (Oligochaeta), commonly referred to as OC species, are more tolerant of environmental stress conditions (Brinkhurst 1962, Beck 1977, and Merritt and Cummins 2008). Stream reaches may be divided into several ecological categories depending upon whether or not they are subject to

stressful agents and, if they are, to what extent or type. These reaches can usually be divided on the basis of the benthic fauna that is supported in that reach.

Clean water streams with variable habitat features often have a high diversity of species with no species numerically dominant. Streams receiving organic pollution generally show a decrease in both taxa richness and diversity and an increase in density (Gaufin and Tarzwell 1956). Streams receiving toxic products frequently show a decrease in taxa richness, diversity and density (Cairns et al., 1971).

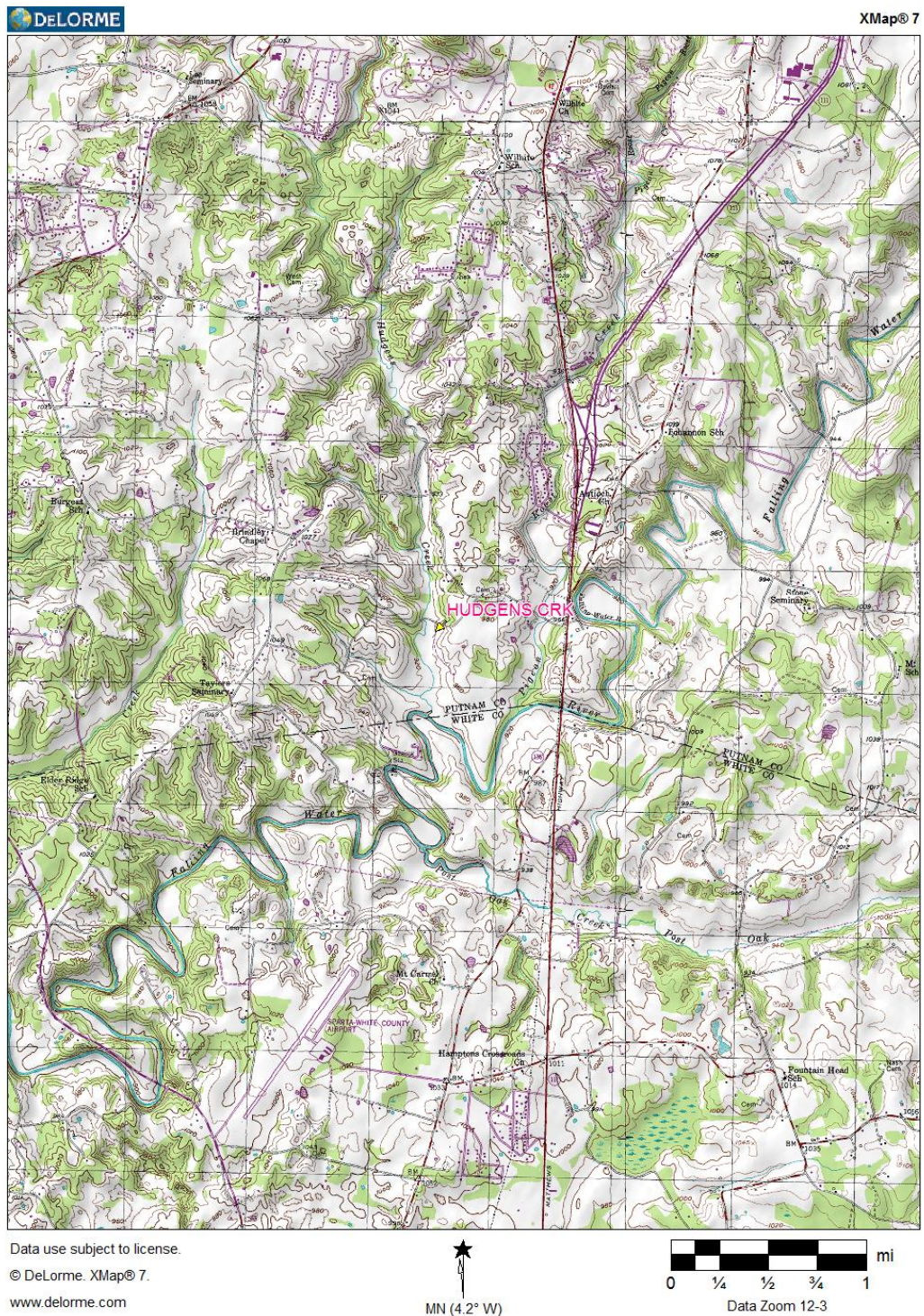
Increased sedimentation in streams is a problem most often the result of poor agriculture practices, construction activity and mining in the vicinity of the streams (Waters, 1995). The effects of increased sedimentation are varied, but the primary effect is scouring during high flows, habitat loss caused by the filling of cracks and crevices with sand and silt (increased embeddeness) and general decrease in habitat diversity which would have a similar effect as toxicity with decreases in taxa richness, diversity and density.

SAMPLE LOCATIONS

The locations in Cane Creek (Photo1) and Hudgens Creek (Photo 2) used for the benthic macroinvertebrate survey are presented in Figures 1 and 2. The study sites were located in the following area.

Cane Creek (CANE011.9PU) –875 feet downstream of I-40 and 163 feet upstream of Lee Seminary Road, Putnam County, Tennessee (N36.13591⁰, W85.56664⁰).

Hudgens Creek (HUDGE000.5PU) –Just downstream of South Lovelady Road, Putnam County, Tennessee (N36.08799⁰, W85.51855⁰).



**Figure 2. Benthic Macroinvertebrate Sampling Location Hudgens Creek,
 Putnam County, Tennessee, April 12, 2017.**

PHYSICAL CHARACTERISTICS

Cane Creek (Photo 1) originates on the Eastern Highland Rim just south of the City of Cookeville in Putnam County, Tennessee at an elevation near 1100 feet. Cane Creek flows south for approximately 15 miles to its confluence with Falling Water River at the Putnam and White Counties line. The drainage of the watershed upstream of the study site is approximately 5.93 square miles. Usage of the watershed is a mixture of agriculture, urban, residential with some light industry.

Hudgens Creek also originates of the Eastern Highland Rim just south of the City of Cookeville at an elevation of approximately by 1100 feet. The creek flows south for about 5 miles to its confluence with Falling Water River at the Putnam and White counties borderline.

Physical characteristics of Cane Creek are presented in Table 1. There was an open canopy (41%) where the samples were taken. The channel was approximately 18 feet wide. Depth was averaged at 0.49 ft and the flow was 6.46 cfs (5.18 cfs when a correction factor was applied). Substrate in the section of Cane Creek used for benthic macroinvertebrate sampling consisted of mostly gravel (73%), silt (10%), cobble (10%) and sand (7%). Habitat was scored as Not Impaired using a consensus of two assessors

Characteristics of the physical habitat of Hudgens Creek (Photo 2) are also found in Table 1. The site in Hudgens Creek had a canopy measured to be 82%. The stream channel was 35 feet wide with the channel where flow was measured about 6 feet wide. Depth within the narrow channel averaged 1.05 feet. Flow was calculated to be 19.34 cfs, or 15.47 cfs when a correction factor of 0.8 is applied. The substrate in Hudgens Creek was mostly bedrock (53%), gravel (24%), silt (15%) with lesser amounts of sand (6%) and cobble (2%). Habitat was scored as Not Impaired using a consensus score of two stream assessors.



Photo 1. Cane Creek, Putnam County, Tennessee, April 12, 2017.



Photo 2. Hudgens Creek, Putnam County, Tennessee, April 12, 2017.

MATERIALS AND METHODS

At each study site in Cane Creek and Hudgens Creek two one meter kick-net samples equivalent to an area of approximately 2m² were taken in the runs and riffles at the areas of low and high velocity. The 2m² Kicks were taken in equal proportions using a coarse (500 µm mesh) seine net. In the field, the samples were transferred to plastic containers labeled on the outside and inside and preserved with 10% formalin.

In the laboratory, all benthic samples were washed in a 250 micron mesh screen. After washing, the macroinvertebrates and debris were transferred to a Caton splitter and split following the State of Tennessee protocols (TDEC 2011). The organisms were removed from the detritus using a stereomicroscope and preserved in 85% ethanol. The organisms were identified to the lowest practical taxonomic level using available keys (Pennington and Associates, Inc. 2014) and counted. Identifications were made with a stereomicroscope (7X to 60X). Slide mounts were made of the chironomids, simuliids, oligochaetes and small crustaceans, and identifications were made with a compound microscope. The chironomids and simuliids were cleared for 24 hours in cold 10% KOH. Temporary mounts were made in glycerin and the animals returned to 80% ethanol after identification. Oligochaetes were mounted on glass slides in the media CMC. When permanent mounts were desired, the organisms were transferred to 95% ethanol for 30 minutes and mounted in Euparal.

SUBSTRATE DETERMINATION

A pebble count following procedures developed by Bevington and King (1995) was conducted at each location sampled for invertebrates. A classification of substrate based on the size scale proposed by Wentworth (Compton 1962) was used to make field observations of the substrate present at each station. This classification of detrital sediments is by grain diameter and is as follows:

Diameters	Approximate Inch Equivalents	Name of Loose Aggregate
>256 mm	>10 inch	Boulder
64 to 256 mm	2.5 to 10 inch	Cobble
2 to 64 mm	0.08 to 2.5 inch	Gravel
1/16 to 2 mm	0.002 to 0.08 inch	Sand
1/256 to 1/16 mm	0.00015 to 0.002 inch	Silt
<1/256 mm	<0.00015 inch	Clay

TENNESSEE PROTOCOL K-Data Reduction of Semi-Quantitative Sample

The Tennessee Division of Water Pollution has developed a Tennessee Macroinvertebrate Index (TMI) based on seven biometrics for use in semi-quantitative macroinvertebrate surveys (Arnwine and Denton 2001). The index is based on stream data from various ecoregions and calibrated by bioregion. According to the Division of Water Pollution the calibrated scoring criteria can be used in all streams that fit the sample criteria for that region (habitat sampled, sampling protocol, and stream size) and have at least 80% of their upstream drainage in the same bioregion.

Conversely, according to Arnwine and Denton (2001) streams that do not meet the profile are those that are non-riffle streams in bioregions that are calibrated to a SQKICK sample or streams that have more than 20% of their upstream drainage in other bioregions. The index tables cannot be used for assessments since these samples are not comparable to streams in the Tennessee Ecoregion Reference Stream Data Base. For streams not comparable to the Tennessee Ecoregion Reference Stream Data Base investigators should compare the seven biometrics to an appropriate upstream or watershed reference.

Core benthic macroinvertebrate community metrics were calculated for each station for comparison to Tennessee Ecoregion Reference Stream Data Base (TDEC 2011). Seven core metrics were calculated and include the following:

1. **Taxa Richness (TR)** – Total number of distinct taxa (genera for comparison to Tennessee Ecoregion Reference Stream Data Base). In general, increasing taxa richness reflects increasing water quality, habitat diversity and habitat suitability (KDOW 2002).

2. **Ephemeroptera, Plecoptera, and Trichoptera Richness (EPT)** – Total number of distinct taxa within the generally pollution sensitive insect orders of EPT. This index value will usually increase with increasing water quality, habitat diversity and habitat stability (Plafkin et al. 1989 and Barbour et al. 1999).
3. **North Carolina Biotic Index (NCBI)** – The Biotic Index was originally developed by Hilsenhoff (1982) as a rapid method for evaluating water quality in Wisconsin streams by summarizing the overall pollution tolerance of a benthic arthropod community with a single value from 0-5. Hilsenhoff (1987) later refined the index and expanded the scale from 0-10. The biotic index is an average of tolerance values, and measures saprobity (pertaining to tolerance of organic enrichment) and to some extent tropism. Range of the index ranges from 0 (no apparent organic pollution) to 10 (severe organic pollution). Tennessee and KDOW use tolerance values developed by North Carolina Division of Environmental Management (NCDEM) (NCDENR 2016), Tolerance Values shown in TDEC (2011) were used in this study. An increasing Biotic Index value indicates decreasing water quality. The formula for the Biotic Index is as follows:

$$NCBI = \sum \frac{x_i t_i}{n}$$

Where: x_i = number of individuals within a taxon

t_i = tolerance value of a taxon

n = total number of individuals in the sample

The state of Tennessee uses a four tier scoring based on Hilsenhoff's values calibrated for each Tennessee ecoregion. TDEC's scoring criteria for biotic index values for streams of the interior plateau ecoregions are as follows:

Ecoregion	Non-impaired	Slightly Impaired	Moderately Impaired	Severely Impaired
Western Pennyroyal Karst (71e)	<5.25	5.25-6.82	6.83-8.40	>8.40
Western Highland Rim (71g)	<4.88	4.88-6.58	6.59-8.29	>8.29
Eastern Highland Rim (71f)	“	“	“	“
Outer Nashville Basin (71h)	“	“	“	“
Inner Nashville Basin (71i)	<5.60	5.60-7.06	7.07-8.53	>8.53

4. **Percent Ephemeroptera, Plecoptera and Trichoptera (EPT-Cheum Abundance):**

$$\% \text{ EPT -Cheum} = \frac{\text{Number of EPT individuals-} \textit{Cheumatopsyche sp.} \text{ Individuals}}{\text{Total Number of individuals}} \times 100$$

This index value will generally increase with increasing water quality, habitat diversity and habitat stability (Plafkin et al. 1989 and Barbour et al. 1999).

5. **Percent Oligochaeta and Chironomidae (%OC)** – This metric measures the relative abundance of generally pollution tolerant organisms. Increasing abundances of oligochaetes and chironomids suggests decreasing water quality and/or habitat conditions (Weber1973).

6. **Percent Tennessee Nutrient Tolerant Organisms (%TNUTOL) –**

$$\% \text{ TNUTOL} = \frac{\text{Total number of } \textit{Cheumatopsyche}, \textit{Lirceus}, \textit{Caenis} \text{ immature } \textit{Tubificidae}, \textit{Stenelmis}, \textit{Elimia}, \textit{Nais}, , \textit{Dero}, \textit{Polypedilum}, \textit{Cricotopus/Orthocladius} \text{ and } \textit{Cricotopus}}{\text{Total individuals in sample}} \times 100$$

An increase of individuals of these taxa suggests increase organic enrichment. (TDEC 2011)

7. **Percent Clingers** (Percent contribution of organisms that build fixed retreats or have adaptations to attach to surfaces in flowing water)-

$$\% \text{ Clingers} = \frac{\text{Total number of clinger individuals}}{\text{Total individuals in sample}} \times 100$$

Many of the clingers are EPT species thus increases in the percent of clingers suggests increasing water quality (Barbour et al. 1999).

The seven metrics; **1.** Taxa richness, **2.** EPT taxa, **3.** NCBI, **4.** % EPT-Cheum, **5.** %OC, **6.** % TNUTOL and **7.** % Clingers calculated for the stream location in Cane Creek and Hudgens Creek were compared to the Tennessee Ecoregion Reference Stream Data Base. The data for the stream location was equalized by assigning a score of 6 (non-impaired), 4 (slightly impaired), 2 (moderately impaired), or 0 (severely impaired) based on comparison to the Tennessee Ecoregion Reference Stream Data Base. (TDEC 2011). The scores were summed to determine biological condition of the stream location.

PHYSICAL AND CHEMICAL PARAMETERS

The physical and field chemical parameters measured included pH, dissolved oxygen, temperature, conductivity, total dissolved solids, turbidity, stream width, depth, velocity and flow. Values of pH, dissolved oxygen, conductivity and temperature were determined with an YSI Professional Plus Series meter. Temperature was also verified with a field centigrade thermometer. Turbidity was measured with a LaMotte Model No. TC-3000e turbidimeter. Canopy cover was determined with a convex spherical densitometer using an average of four readings (Lemmon 1957). Width of the streambed was taken at each station using a tape measure. Depth was taken at approximate one-foot intervals across the stream at the location used for width measurements. Average depth was determined by adding the readings taken across the stream at each location used for width measurement and dividing by one more than the number of readings. This is to allow for 0 depth at each side (Lagler 1973). Velocity was measured approximately every two feet across the stream with a Gurley Flow Meter.

Approximate flow was determined by the following formula:

$$R = V D a W$$

Where R is equal to the volume of flow in cubic feet per second (cfs); W is average width in feet; D is average depth in feet; V is the velocity (ft/sec); and a is a constant for correction of stream velocity (0.8 if the bottom is strewn with rocks and coarse gravel, 0.9 if smooth).

RESULTS AND DISCUSSION

Physical and water quality characteristics of Cane Creek and Hudgens Creek as found on April 12, 2017 are presented in Table 1. A list of all aquatic benthic macroinvertebrate taxa collected from the two creeks with assigned tolerance values, habit and functional feeding groups are shown in Table 2. A summary of Tennessee Bioassessment benthic macroinvertebrate metrics, scoring and index ratings are found in Table 3. All field data including habitat assessment filed data sheets are presented in the appendix.

Water quality (Table 1) found in Cane Creek had pH (7.60) slightly alkaline, dissolved oxygen (8.41 mg/l), temperature (14.6°C), conductivity (201.9 μ S/cm) and TDS (183ppm) all near background levels for this ecoregion. Turbidity was 6.71 ntu's which would be considered slightly turbid.

The water quality parameters measured in Hudgens Creek were very similar to those monitored in Cane Creek with pH (7.87) slightly alkaline, dissolved oxygen (9.29 mg/l) near 90% saturation and temperature 14.4°C. Conductivity (214.0 μ S/cm) and TDS (192 ppm) also near background levels for this area. Turbidity (3.77 ntu's) was clear (Table 1).

Cane Creek supports a fairly diverse benthic macroinvertebrate fauna at this location with a minimum of 34 genera represented (Table 2). Most of the individuals in the benthic fauna as found in 2013 were aquatic insects with a few worms, snails and crustaceans also represented. There was a minimum of five species representing sensitive EPT taxa. Even though there were sensitive EPT species present, the three dominant taxa included the non-biting midge (Chironomidae) *Polypedilum* spp. (25.5%), tubificid worms (10.2%) and the riffle beetle *Stenelmis* sp. (9.2%). Because of the high numbers of nonbiting midges considered nutrient tolerant in the benthic macroinvertebrate fauna and the low number of EPT species, Cane Creek had a TMI score of 18 out of a possible 42 (Table 3). This is short of the TMI score of 32 required to pass biocriteria.

Hudgens Creek was found to have a diverse benthic macroinvertebrates fauna represented by a minimum of 37 genera (Table 2). There was a minimum of 10 EPT taxa represented in the benthic fauna. The most abundant genera were the blackfly *Simulium* spp. (23.9%), the non – biting midges *Parametriocnemus* spp. (15.1%) and *Tvetenia* spp. (7.8%), and the mayfly *Plauditus* sp. (7.8%). The TMI score of 34 has this location passing biocriteria since it exceeds the 32 required.

Table 1. Water Quality and Physical Parameters, Cane Creek and Hudgens Creek, Putnam County, Tennessee, April 12, 2017.		
PARAMETER	Cane Creek	Hudgens Creek
	CANE011.9PU	HUDGE000.5PU
PH (Std. Units)	7.60	7.87
Dissolved Oxygen (mg/l)	8.41	9.29
Temperature (°C)	14.6	14.4
Conductivity (μs)	201.9	214.0
Turbidity (ntu's)	6.71	3.77
Total Dissolved Solids/ppm	183	192
Stream Width (ft)	18	6 (35 channel)
Average Depth (ft)	0.486	1.05
Velocity (ft/sec)	0.739	3.07
^a Velocity (ft/sec)	0.591	2.456
Flow (ft ³ /sec)	6.465	19.341
^a Flow (ft ³ /sec)	5.170	15.473
Canopy Cover (%)	41	82
HABITAT SCORE	134.5	136.5
RATING	Not Impaired	Not Impaired

Table 1 (continued). Water Quality and Physical Parameters, Cane Creek, Putnam County, Tennessee, April 12, 2017.					
PARAMETER		Cane Creek		Hudgens Creek	
		CANE011.9PU		HUDGE000.5PU	
SUBSTRATE	(mm)	COUNT	%	COUNT	%
SILT/CLAY TOTAL	<0.062	10	10%	15	15%
Very fine sand	0.062-0.125			5	
Fine sand	0.125-0.25	1		1	
Medium sand	0.25-0.50	2			
Coarse sand	0.50-1.0				
Very coarse sand	1-2	4			
SAND TOTAL			7%		6%
Very fine gravel	2-4	10			
Fine gravel	4-6				
Fine gravel	6-8			2	
Medium gravel	8-12	2		3	
Medium gravel	12-16	6		4	
Coarse gravel	16-24	16		4	
Coarse gravel	24-32	14		3	
Very coarse gravel	32-48	19		4	
Very coarse gravel	48-64	6		4	
GRAVEL TOTAL			73%		24%
Small cobble	64-96	7		1	
Small cobble	96-128	2		1	
Large cobble	128-192	1			
Large cobble	192-256				
COBBLE TOTAL			10%		2%
Small boulder	256-384				
Small boulder	384-512				
Medium boulder	512-1024				
Very large boulder	1024-4096				
BOULDER TOTAL					
BEDROCK TOTAL	>4096			53	53%

^a Correction factor for velocity, 0.9 if smooth substrate, 0.8 if rough

Table 2. Benthic Macroinvertebrates taken from Cane Creek and Hudgens Creek, Putnam County, Tennessee, April 12, 2017.					
STATION				CANE011.9PU	HUDGE000.5PU
SPECIES	*T.V.	**F.F.G.	***CL		
PLATYHELMINTHES	6.1				
Turbellaria					
Tricladida					
Dugesidae					
<i>Girardia sp.</i>	7.23	P		1	
NEMATODA	6.02	CG			2
MOLLUSCA					
Bivalvia					
Veneroida					
Corbiculidae					
<i>Corbicula sp.</i>	6.12	FC			2
Sphaeriidae	6.6	FC			
<i>Sphaerium sp.</i>	7.58	FC		1	
Gastropoda					
Mesogastropoda					
Pleuroceridae	3.4				
<i>Elimia sp.</i>	2.46	SC		10	2
ANNELIDA					
Clitellata					
Oligochaeta		CG			
Tubificida					
Enchytraeidae	9.84	CG		1	1
Naididae					
Naidinae	6.1	CG			
<i>Bratislavia sp.</i>	6			1	
<i>Nais sp.</i>	8.88	CG		7	7
<i>Slavina sp.</i>	7.06	CG			1
Tubificinae w.o.h.c.	9.5	CG		20	1
Pristininae					
<i>Pristina sp.</i>	7.74	CG		1	
ARTHROPODA					
Arachnoidea					
Acariformes	5.53				
Sperchontidae	5.53				
<i>Sperchon sp.</i>	5.53				4
Crustacea					
Isopoda					
<i>Caecidotea sp.</i>	9.11	CG		1	

Table 2 (continued). Benthic Macroinvertebrates taken from Cane Creek and Hudgens Creek, Putnam County, Tennessee, April 12, 2017.					
STATION				CANE011.9PU	HUDGE000.5PU
SPECIES	*T.V.	**F.F.G.	***CL		
Amphipoda	7.4	CG			
Gammaridae					
<i>Gammarus sp.</i>	9.1	SH		4	
Decapoda					
Cambaridae					
<i>Cambarus sp.</i>	7.62	CG		1	
Insecta					
Ephemeroptera					
Baetidae	6.1	CG		3	
<i>Acentrella sp.</i>	3.6	CG			6
<i>Baetis sp.</i>	4.51	CG		9	4
<i>Plauditus sp.</i>	4.51	CG		2	17
Heptageniidae	4	SC	CL		
<i>Maccaffertium sp.</i>	3.15	SC	CL		3
Isonychiidae		FC			
<i>Isonychia sp.</i>	3.45	FC			1
Plecoptera					
Nemouridae	1.2	SH			
<i>Amphinemura sp.</i>	3.33	SH			1
Taeniopterygidae		SH			
<i>Taeniopteryx sp.</i>	5.37	SH			1
Trichoptera					
Brachycentridae		SH			
<i>Micrasema sp.</i>	0.56	SH	CL		2
Glossosomatidae	1	SC	CL		
<i>Glossosoma sp.</i>	1.55	SC	CL	1	
Hydropsychidae	4	FC	CL	14	5
<i>Cheumatopsyche sp.</i>	6.22	FC	CL	2	6
<i>Hydropsyche sp.</i>	4.3	FC	CL	1	
Philopotamidae	1.4	FC	CL		
<i>Chimarra sp.</i>	2.76	FC	CL		1
Coleoptera					
Elmidae	6	CG	CL		
<i>Dubiraphia sp.</i>	5.93	SC	CL		1
<i>Optioservus sp.</i>	2.36	SC	CL		3
<i>Stenelmis sp.</i>	5.1	SC	CL	18	1
Psephenidae		SC			
<i>Ectopria sp.</i>	4.16	SC	CL		1

Table 2 (continued). Benthic Macroinvertebrates taken from Cane Creek and Hudgens Creek, Putnam County, Tennessee, April 12, 2017.					
STATION				CANE011.9PU	HUDGE000.5PU
SPECIES	*T.V.	**F.F.G.	***CL		
Diptera					
Ceratopogonidae	5.9	P		1	1
Chironomidae	6.2				
<i>Brillia sp.</i>	5.18	SH			1
<i>Cladotanytarsus sp.</i>	4.09	FC		1	
<i>Conchapelopia sp.</i>	4.5	P		2	
<i>Corynoneura sp.</i>	6.01	CG		1	
<i>Cricotopus sp.</i>	5.78	CG	CL		9
<i>Cryptochironomus sp.</i>	6.4	P		1	
<i>Eukiefferiella sp.</i>	3.43	CG		4	5
<i>Nilotanypus sp.</i>	3.9			1	
<i>Orthocladius sp.</i>	5.95	CG			2
<i>Parakiefferiella sp.</i>	5.4	CG			2
<i>Parametriochnemus sp.</i>	3.65	CG		12	33
<i>Paratendipes sp.</i>	5.11			2	
<i>Polypedilum sp.</i>	5.69	SH		50	8
<i>Rheocricotopus sp.</i>	7.3	CG		1	
<i>Rheotanytarsus sp.</i>	5.89	FC	CL	2	11
<i>Tanypodinae</i>				1	
<i>Tanytarsus sp.</i>	6.76	FC			1
<i>Thienemanniella sp.</i>	5.86	CG			1
<i>Tvetenia sp.</i>	3.65	CG		11	17
Empididae	7.6	P			
<i>Hemerodromia sp.</i>	7.57	P		1	1
Simuliidae	3.5	FC	CL		
<i>Simulium sp.</i>	4	FC	CL	6	52
Tipulidae	4.9	SH			
<i>Antocha sp.</i>	4.25	CG	CL		1
<i>Pseudolimnophila sp.</i>	7.22	P		1	
TOTAL NO. OF ORGANISMS				196	218
TOTAL NO. OF TAXA				36	38
^a TOTAL NO. OF TAXA				34	37
EPT				7	11
^a EPT				5	10

Legend for Table 2. Benthic Macroinvertebrates taken from Cane Creek and Hudgens Creek, Putnam County, Tennessee, April 12, 2017.

^a Organisms identified to order, family and subfamily are not included in total taxa or EPT counts (marked in bold) if an organism is identified to genera under that order, family or subfamily unless it exhibits characteristics indicating it is not one of the genera listed.

* Tennessee Tolerance Values range from 0 for organisms very intolerant of organic wastes to 10 for organisms very tolerant of organic wastes

** F.F.G. – Functional Feeding Group: CG = Collector / Gatherer, FC = Filtering / Collectors, SC = Scraper, SH = Shredders, P= Predators and PI = Pierce, Habit CL = Clinger Organisms

*** CL – Designated Clinger Taxa

Table 3. Summary of Tennessee Bioassessment Metrics, Protocol K, Cane Creek and Hudgens Creek, Putnam County, Tennessee, April 12, 2017.				
METRIC	STATION			
	Cane Creek		Hudgens Creek	
	CANE011.9PU		HUDGE000.5PU	
	Value	Score	Value	Score
Taxa Richness (Genera)	34	6	37	6
EPT Taxa Richness (Genera)	5	2	10	6
% EPT- Cheumatopsyche	15.31	0	18.81	2
%Oligochaeta and Chironomidae (%OC)	60.71	2	45.87	4
North Carolina Biotic Index (NCBI)	5.58	4	4.54	6
Percent Clingers (%CL)	22.45	2	44.04	4
Percent TNUTOL	54.59	2	15.60	6
TOTAL VALUE		18		34
INDEX SCORE	Not Passing Biocriteria		Passing Biocriteria	

Bioregion 71g Eastern Highland Rim - Target Score 32.

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APPENDIX

WPC STREAM SURVEY FIELD SHEET (Front)

STREAM SURVEY INFORMATION		
Station ID: <u>CANE 011.9PU</u>	Assessors: <u>WLP, DEJ, CW, BG</u>	
Stream Name: <u>Cane Creek</u>	Date: <u>4/12/17</u>	Time: <u>7:57</u>
Station Location: <u>US Highland Park Blvd</u>	Stream Order: <u>2nd</u>	RM: <u>11.7</u>
County: <u>Putnam</u>	Drainage Area (sq mi): <u>5.93</u>	Watershed Group #
WBID/HUC: <u>05130108</u>	Ecoregion: <u>71g</u>	U/S Eco:
Latitude DEC/DEG: <u>N 36.13591°</u>	TOPO: <u>Cookeville</u>	Gaz. Page:
Longitude DEC/DEG: <u>W 85.56664°</u>	Drainage (Basin): <u>Cane Fork River</u>	

PROJECT/PURPOSE (circle): Watershed 303(d) Antideg Reference Other (describe)

SAMPLES COLLECTED	
Biorecon EFO Log #	Periphyton EFO Log #
SQKICK EFO Log # <u>✓ 49934</u>	Fish EFO Log #
SQBANK EFO Log #	Other Log #

CHEM/BACTI (circle): None Routine Nutrients Metals Bacti Other

FIELD MEASUREMENTS		Meters Used:	
pH (su)	<u>7.60</u>	Dissolved Oxygen (ppm)	<u>8.41</u> <u>82.9%</u>
Conductivity (umhos)	<u>201.9</u>	Turbidity	<u>6.71</u>
Temperature (°C)	<u>14.6°</u>	TDS	<u>183 ppm</u>

Meter problems/comments:

Previous 48 hrs precipitation: Unknown None Slight Moderate Heavy Flooding

Ambient Weather: Sunny Cloudy Breezy Rain Snow Air temp (°F):

WATERSHED CHARACTERISTICS Approx. % of Watershed Observed:

Upstream surrounding land use (estimated %):					
Pasture	<u>40</u>	Residential	<u>50</u>	Industry	<u>10%</u>
Crops	<u>5</u>	Commercial	<u>5</u>	Mining	
Forest		Urban		Impoundment	

PHYSICAL STREAM CHARACTERISTICS Approx Length of Stream Assessed (m):

Surrounding land use (estimated %):											
<input checked="" type="checkbox"/>	RDB	LDB	<input checked="" type="checkbox"/>	RDB	LDB	<input checked="" type="checkbox"/>	RDB	LDB	OTHERS	RDB	LDB
Pasture			Residential			Industry					
Crops			Commercial			Mining					
Forest			Urban			Wetland	<u>100</u>	<u>100</u>	<u>Constructed wet</u>		

Observed Human Disturbance to Stream: S (slight) M (moderate) H (high) Blank = not observed

ATV/OHV		Construction	<u>S</u>	Livestock		Residential	<u>M</u>
Industrial	<u>M</u>	Impoundment	<u>H</u>	STP/WWTP		Riparian Loss	
Logging		Row Crop	<u>S</u>	Mining		Water withdrawal	
Urban:	<u>M</u>	Road/Hwy	<u>M</u>	Dredging			
Other (describe):	<u>Relocated Stream</u>						

% Canopy Cover: Estimated reach average: Open (0-10) Partly Shaded (11-45) Mostly Shaded (46-80) Shaded (> 80)

Measured mid reach: 40 U/S 30 D/S 24 LB 64 RB 41 Total/384*100

Sediment Deposits:	None	<u>Slight</u>	Moderate	High	Excessive	Blanket
Sediment Type:	Sludge	Mud	<u>Sand</u>	<u>Silt</u>	None	Other
Turbidity:	Clear	<u>Slight</u>	Moderate	High	Opaque	Color
Surface Sheen/foam:	Bacteria	Nutrient	Surfactant	Other	<u>None</u>	
Algae Present?	None	Slight	<u>Moderate</u>	High	Choking	Type: <u>Diatom</u> <u>Green</u> <u>Filamentous</u> Blue-green

Comments:

WPC STREAM SURVEY FIELD SHEET (Back)

Station ID	CANE 011.9 pu	Date	7/12/17	Assessors	WLI?
	Riffle	Run	Pool	Staff Gauge/Bench Ht	
Depth (m)				Flow (cfs)	
Width (m)				High Water Mark (m)	
Reach Length (m)				Bank Height (m)	

Flow Conditions: Dry Isolated Pools Low Moderate High Bankfull Flooding Other _____
 Gradient (sample reach): Flat Low Moderate High Cascade Other _____
 Size (stream width): V. small (< 1.5m) Small (1-5.3 m) Med. (3-10 m) Large (10-25 m) V. Large (> 25m)

Substrate Percent (visual estimates):

	Riffle	Run	Pool		Riffle	Run	Pool
Boulder (> 10")				Clay (Slick)			
Cobble (2.5-10")				Silt			
Gravel (0.1-2.5")				Detritus (CPOM)			
Bedrock				Muck-Mud (FPOM)			
Sand (Gritty)				Marl (Shell frags.)			

Field Based Assessment

Biorecon Score if Applicable _____ Indicate level: Family Genus
 If SQSH not collected does benthic community appear impaired? Yes No

Info from other field sheets (optional)

BR TR _____ EPT _____ INTOL _____
 Habitat Score HG _____ LG _____

Describe basis for determination including possible sources of impairment:

Additional Stream Information 3 Orconectes returned with eggs.

Photos? Yes No ID and Description 4393- 4399

Stream Sketch: (include flow direction, reach distance, distance from bridge, nearest road, sampling points, tribs, outfalls, livestock access, riparian area, potential impacts, etc. Use additional sheet if needed).

width (ft)	Depth (ft)	Velocity (ft/sec)
18'	0.4 0.6	0 0.788
	0.6 0.4	0 0.996
	0.5 0.3	0.687 0.866
	0.5 0.2	0.560 0.387
	0.4 0.486 ft	1.450 0.739 ft/sec
	0.6	1.343 6.465 cfs
	0.6	0.665 40.8 cfs
	0.6	0.870 0.591 ft/sec with cfs
	0.6	1.114 5.170 cfs with cfs
	0.5	0.615

Pennington and Associates, Inc.
PEBBLE COUNT SHEET

Stream Name Cane Creek Date 4/12/17 Time 8:00
 Station CANE 011.9PU County Putnam WRD# HUC05130108
 Ecoregion 715 Lat/Long N 36.13591 W 85.56664
 Assessors W. P. JES, B.G., C.W. Project Cookeville TMDL

Size Class	Size Range mm (inches)	Count	Total	% Cum.
SILT/CLAY	<0.062 (<0.002)		10	10%
SAND-Very Fine	0.062-0.125 (0.002-0.005)			
Fine	0.125-0.25 (0.005-0.01)	1	1	
Medium	0.25-0.50 (0.01-0.02)	11	2	
Coarse	0.50-1.0 (0.02-0.04)			
Very Coarse	1-2 (0.04-0.08)		4	
	SAND TOTAL			7%
GRAVEL-Very Fine	2-4 (0.08-0.16)		10	
Fine	4-6 (0.16-0.24)			
	6-8 (0.24-0.31)			
Medium	8-12 (0.31-0.47)	11	2	
	12-16 (0.47-0.63)		6	
Coarse	16-24 (0.63-0.9)		16	
	24-32 (0.9-1.3)		14	
Very Coarse	32-48 (1.3-1.9)		19	
	48-64 (1.9-2.5)		6	
	GRAVEL TOTAL			73%
COBBLE-Small	64-96 (2.5-3.8)		7	
	96-128 (3.8-5.0)	11	2	
Large	128-192 (5.0-7.6)	1	1	
	192-256 (7.6-10.1)			
	COBBLE TOTAL			10%
BOULDER-Small	256-384 (10.1-15.1)			
	384-512 (1.25'-1.7')			
Medium	512-1024 (1.7'-3.3')			
Large-Very Large	1024-4096 (3.3'-13.4')			
	BOULDER TOTAL			
	BEDROCK >13.4'			

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (FRONT)
 (See Protocol E for detailed descriptions and rank information)

STATION ID: <u>CANE 011-9 PU</u>					HABITAT ASSESSED BY: <u>WLP + DJ</u>															
STREAM NAME: <u>Cane Creek</u>					DATE: <u>4/12/17</u> TIME: <u></u>															
STATION LOCATION: <u>Upstream Highland Park Blvd</u>					ECOREGION: <u>71g</u> QC: <u>Consensus</u> Duplicate															
WBID/HUC: <u>HUC 65130108</u> GROUP: <u></u>					ASSOCIATED LOG #: <u>PA 49834</u>															
	Optimal				Suboptimal				Marginal				Poor							
1. Epifaunal Substrate/ Available Cover	Over 70% of stream reach has natural stable habitat suitable for colonization by fish and/or macroinvertebrates. Four or more productive habitats are present.				Natural stable habitat covers 40-70% of stream reach. Three or more productive habitats present. (If near 70% and more than 3 go to optimal.) <u>12.5</u>				Natural stable habitat covers 20 -40% of stream reach or only 1-2 productive habitats present. (If near 40% and more than 2 go to suboptimal.)				Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.							
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Comments																				
2. Embeddedness of Riffles	Gravel, cobble, and boulders 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. If near 25% drop to suboptimal if riffle not layered cobble.				Gravel, cobble and boulders 25-50% surrounded by fine sediment. Niches in bottom layers of cobble compromised. If near 50% & riffles not layered cobble drop to marginal.				Gravel, cobble, and boulders are 50-75% surrounded by fine sediment. Niche space in middle layers of cobble is starting to fill with fine sediment.				Gravel, cobble, and boulders are more than 75% surrounded by fine sediment. Niche space is reduced to a single layer or is absent.							
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Comments																				
3. Velocity/ Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).				Only 3 of the 4 regimes present (if fast-shallow is missing score lower). If slow-deep missing score 15.				Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).				Dominated by 1 velocity/depth regime. Others regimes too small or infrequent to support aquatic populations.							
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Comments																				
4. Sediment Deposition	Sediment deposition affects less than 5% of stream bottom in quiet areas. New deposition on islands and point bars is absent or minimal.				Sediment deposition affects 5-30% of stream bottom. Slight deposition in pool or slow areas. Some new deposition on islands and point bars. Move to marginal if build-up approaches 30%.				Sediment deposition affects 30-50% of stream bottom. Sediment deposits at obstruction, constrictions and bends. Moderate pool deposition. <u>8.5</u>				Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.							
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Comments																				
5. Channel Flow Status.	Water reaches base of both lower banks and streambed is covered by water throughout reach. Minimal productive habitat is exposed.				Water covers > 75% of streambed or 25% of productive habitat is exposed.				Water covers 25-75% of streambed and/or productive habitat is mostly exposed.				Very little water in channel and mostly present as standing pools. Little or no productive habitat due to lack of water.							
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Comments																				

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (BACK)

Station ID <u>CANE 011.9 PU</u>		Date <u>4/12/17</u>		Initials <u>WLP & DJ</u>	
	Optimal	Suboptimal	Marginal	Poor	
6. Channel Alteration	Channelization, dredging rock removal or 4-wheel activity (past or present) absent or minimal; natural meander pattern. NO artificial structures in reach. Upstream or downstream structures do not affect reach.	Channelization, dredging or 4-wheel activity up to 40%. Channel has stabilized. If larger reach, channelization is historic and stable. Artificial structures in or out of reach do not affect natural flow patterns.	Channelization, dredging or 4-wheel activity 40-80% (or less that has not stabilized.) Artificial structures in or out of reach may have slight affect.	Over 80% of reach channelized, dredged or affected by 4-wheelers. Instream habitat greatly altered or removed. Artificial structures have greatly affected flow pattern.	
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 <u>2</u> 1	
Comments					
7. Frequency of re-oxygenation zones. Use frequency of riffle or bends for category. Rank by quality.	Occurrence of re-oxygenation zones relatively frequent; ratio of distance between areas divided by average stream width <7:1.	Occurrence of re-oxygenation zones infrequent; distance between areas divided by average stream width is 7 - 15.	Occasional re-oxygenation area. The distance between areas divided by average stream width is over 15 and up to 25.	Generally all flat water or flat bedrock; little opportunity for re-oxygenation. Distance between areas divided by average stream width >25.	
SCORE	20 19 18 17 16 <u>15</u>	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	
Comments					
8. Bank Stability (score each bank) Determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. If approaching 30% score marginal if banks steep.	Moderately unstable; 30-60 % of bank in reach has areas of erosion; high erosion potential during floods. If approaching 60% score poor if banks steep.	Unstable; many eroded area; raw areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.	
SCORE (LB)	Left Bank 10 9 <u>8</u>	8 7 6	5 4 3	2 1 0	
SCORE (RB)	Right Bank 10 9 <u>8</u>	8 7 6	5 4 3	2 1 0	
Comments					
9. Vegetative Protective (score each bank) includes vegetation from top of bank to base of bank. Determine left or right side by facing downstream	More than 90% of the bank covered by undisturbed vegetation. All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally. All plants are native.	70-90% of the bank covered by undisturbed vegetation. One class may not be well represented. Disruption evident but not effecting full plant growth. Non-natives are rare (<30%)	50-70% of the bank covered by undisturbed vegetation. Two classes of vegetation may not be well represented. Non-native vegetation may be common (30-50%).	Less than 50% of the bank covered by undisturbed vegetation or more than 2 classes are not well represented or most vegetation has been cropped. Non-native vegetation may dominate (>50%)	
SCORE (LB)	Left Bank 10 9 <u>8</u>	8 <u>7</u> 6	5 4 3	2 1 0	
SCORE (RB)	Right Bank 10 9 <u>8</u>	8 <u>7</u> 6	5 4 3	2 1 0	
Comments <u>Created wetlands planted approximately 5 years ago</u>					
10. Riparian Vegetative Zone Width (score each bank.) Zone begins at top of bank.	Average width of riparian zone > 18 meters. Unpaved footpaths may score 9 if run-off potential is negligible.	Average width of riparian zone 12-18 meters. Score high if areas < 18 meters are small or are minimally disturbed.	Average width of riparian zone 6-11 meters. Score high if areas less than 12 meters are small or are minimally disturbed.	Average width of riparian zone <6 meters. Score high if areas less than 6 meters are small or are minimally disturbed.	
SCORE (LB)	Left Bank <u>10</u> 9	8 7 6	5 4 3	2 1 0	
SCORE (RB)	Right Bank <u>10</u> 9	8 7 6	5 4 3	2 1 0	
Comments <u>Created wetlands planted approximately 5 years ago</u>					

Total Score 134.5

Comparison to Ecoregion Guidelines (circle): ABOVE or BELOW

If score is below guidelines , result of (circle): Natural Conditions or Human Disturbance

Describe

WPC STREAM SURVEY FIELD SHEET (Front)

STREAM SURVEY INFORMATION		
Station ID: <u>HU DG000.5 PU</u>	Assessors: <u>WLP, DES, BG, CW</u>	
Stream Name: <u>Hudgens Creek</u>	Date: <u>4/12/17</u>	Time: <u>9:12 AM CST</u>
Station Location: <u>off S. Lovelady Rd</u>	Stream Order: <u>2nd</u>	RM: <u>0.5</u>
County: <u>Putnam Co. TN</u>	Drainage Area (sq mi):	Watershed Group #
WBID/HUC: <u>HUC 05130108</u>	Ecoregion: <u>71g</u>	U/S Eco:
Latitude DEC/DEG: <u>N 36.08799</u> <u>20'</u>	TOPO:	Gaz. Page:
Longitude DEC/DEG: <u>W 85.51855</u>	Drainage (Basin): <u>Cane Fork River</u>	

PROJECT/PURPOSE (circle): Watershed 303(d) Antideg Reference Other (describe)

SAMPLES COLLECTED	
Biorecon EFO Log #	Periphyton EFO Log #
SQKICK EFO Log # <u>PA49835</u>	Fish EFO Log #
SQBANK EFO Log #	Other Log #

CHEM/BACTI (circle): None Routine Nutrients Metals Bacti Other

FIELD MEASUREMENTS		Meters Used:	
pH (su)	<u>7.87</u>	Dissolved Oxygen (ppm)	<u>9.29</u> <u>90.9</u>
Conductivity (umhos)	<u>214.2</u>	Turbidity	<u>3.77</u> <u>0.0</u>
Temperature (°C)	<u>14.4</u>	TDS	<u>192 ppm</u>

Meter problems/comments:

Previous 48 hrs precipitation: Unknown None Slight Moderate Heavy Flooding

Ambient Weather: Sunny Cloudy Breezy Rain Snow Air temp (°F):

WATERSHED CHARACTERISTICS Approx. % of Watershed Observed:

Upstream surrounding land use (estimated %):			
Pasture	<u>50</u>	Residential	<u>20</u>
Crops	<u>< 10</u>	Commercial	
Forest	<u>20</u>	Urban	

PHYSICAL STREAM CHARACTERISTICS Approx Length of Stream Assessed (m):

Surrounding land use (estimated %):			
Pasture	RDB	LDB	
Pasture	<u>100</u>	<u>100</u>	
Crops			
Forest			

Observed Human Disturbance to Stream: S (slight) M (moderate) H (high) Blank = not observed

ATV/OHV		Construction		Livestock	<u>S-M</u>	Residential	<u>H</u>
Industrial		Impoundment		STP/WWTP		Riparian Loss	
Logging		Row Crop	<u>S</u>	Mining		Water withdrawal	
Urban:	<u>11</u>	Road/Hwy	<u>S</u>	Dredging			
Other (describe):							

% Canopy Cover: Estimated reach average: Open (0-10) Partly Shaded (11-45) Mostly Shaded (46-80) Shaded (> 80)

Measured mid reach: 88 U/S 56 D/S 76 LB 94 RB 82 Total/384*100

Sediment Deposits:	None	<u>Slight</u>	Moderate	High	Excessive	Blanket
Sediment Type:	Sludge	Mud	Sand	<u>Silt</u>	None	Other
Turbidity:	Clear	<u>Slight</u>	Moderate	High	Opaque	Color
Surface Sheen/foam:	Bacteria	Nutrient	Surfactant	Other	<u>None</u>	
Algae Present?	None	<u>Slight</u>	<u>Moderate</u>	High	Choking	Type: Diatom Green <u>Filamentous</u> Blue-green

Comments:

WPC STREAM SURVEY FIELD SHEET (Back)

Station ID	HUDG000.5 PM			Date	4/12/17	Assessors	WLP, DES, BG, CW
	Riffle	Run	Pool			Staff Gauge/Bench Ht	
Depth (m)						Flow (cfs)	
Width (m)						High Water Mark (m)	
Reach Length (m)						Bank Height (m)	

Flow Conditions: Dry Isolated Pools Low Moderate High Bankfull Flooding Other _____
 Gradient (sample reach): Flat Low Moderate High Cascade Other _____
 Size (stream width): V. small (< 1.5m) Small (1-5.3 m) Med. (3-10 m) Large (10-25 m) V. Large (> 25m)

Substrate Percent (visual estimates):

	Riffle	Run	Pool		Riffle	Run	Pool
Boulder (> 10")				Clay (Slick)			
Cobble (2.5-10")				Silt			
Gravel (0.1-2.5")				Detritus (CPOM)			
Bedrock				Muck-Mud (FPOM)			
Sand (Gritty)				Marl (Shell frags.)			

Field Based Assessment

Biorecon Score if Applicable _____ Indicate level: Family Genus
 If SQSH not collected does benthic community appear impaired? Yes No
 Habitat Score HG _____ LG _____

Describe basis for determination including possible sources of impairment:

Additional Stream Information large Camberus ♂ returned

Photos? Yes No ID and Description 4400-4403

Stream Sketch: (include flow direction, reach distance, distance from bridge, nearest road, sampling points, tribs, outfalls, livestock access, riparian area, potential impacts, etc. Use additional sheet if needed).

width (ft) where flow taken 6'
 channel width 35'
 Depth (ft) 0.8
0.2
1.5
1.7
1.05 ft
 width (ft/sec) 4.113
3.312
2.720
2.134
3.06975
or 3.07
cf 0.8 = 2.456
19.341 cfs
15.473 cfs with cf

Pennington and Associates, Inc.
PEBBLE COUNT SHEET

Stream Name Hudgens Creek Date 4/12/17 Time 9:12 AM CST
 Station HUDG000.5 PU County Putnam WRD# 05130108
 Ecoregion 71G Lat/Long N36.06799 W85.51855
 Assessors DES, BG, CW, WLP Project City of Cookeville TMDL

Size Class	Size Range mm (inches)	Count	Total	% Cum.
SILT/CLAY	<0.062 (<0.002)		15	15%
SAND-Very Fine	0.062-0.125 (0.002-0.005)		5	
Fine	0.125-0.25 (0.005-0.01)	1	1	
Medium	0.25-0.50 (0.01-0.02)			
Coarse	0.50-1.0 (0.02-0.04)			
Very Coarse	1-2 (0.04-0.08)			
	SAND TOTAL			6%
GRAVEL-Very Fine	2-4 (0.08-0.16)			
Fine	4-6 (0.16-0.24)			
	6-8 (0.24-0.31)		2	
Medium	8-12 (0.31-0.47)		3	
	12-16 (0.47-0.63)		4	
Coarse	16-24 (0.63-0.9)		4	
	24-32 (0.9-1.3)		3	
Very Coarse	32-48 (1.3-1.9)		4	
	48-64 (1.9-2.5)		4	24%
	GRAVEL TOTAL			24%
COBBLE-Small	64-96 (2.5-3.8)	1	1	
	96-128 (3.8-5.0)	1	1	
Large	128-192 (5.0-7.6)			
	192-256 (7.6-10.1)			
	COBBLE TOTAL			2%
BOULDER-Small	256-384 (10.1-15.1)			
	384-512 (1.25'-1.7')			
Medium	512-1024 (1.7'-3.3')			
Large-Very Large	1024-4096 (3.3'-13.4')			
	BOULDER TOTAL			
	BEDROCK >13.4'		53	53%

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (FRONT)
(See Protocol E for detailed descriptions and rank information)

STATION ID: <u>HUDG000.5PU</u>		HABITAT ASSESSED BY: <u>WLP + DJ</u>	
STREAM NAME: <u>Hudgens Creek</u>		DATE: <u>4/12/17</u> TIME: <u>9:12</u>	
STATION LOCATION: <u>N 36.08799</u>		ECOREGION: <u>719</u> QC: <u>(Consensus)</u> Duplicate	
WBID/HUC: <u>05130108</u> <u>W 05-51055</u> GROUP:		ASSOCIATED LOG #: <u>49835</u>	
	Optimal	Suboptimal	Marginal
1. Epifaunal Substrate/ Available Cover	Over 70% of stream reach has natural stable habitat suitable for colonization by fish and/or macroinvertebrates. Four or more productive habitats are present.	Natural stable habitat covers 40-70% of stream reach. Three or more productive habitats present. (If near 70% and more than 3 go to optimal.)	Natural stable habitat covers 20-40% of stream reach or only 1-2 productive habitats present. (If near 40% and more than 2 go to suboptimal.)
SCORE	20 19 18 <u>17</u> 16	15 14 13 12 11	10 9 8 7 6
Comments			
	Optimal	Suboptimal	Marginal
2. Embeddedness of Riffles	Gravel, cobble, and boulders 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. If near 25% drop to suboptimal if riffle not layered cobble.	Gravel, cobble and boulders 25-50% surrounded by fine sediment. Niches in bottom layers of cobble compromised. If near 50% & riffles not layered cobble drop to marginal.	Gravel, cobble, and boulders are 50-75% surrounded by fine sediment. Niche space in middle layers of cobble is starting to fill with fine sediment.
SCORE	20 19 18 <u>17</u> 16	15 14 13 12 11	10 9 8 7 6
Comments			
	Optimal	Suboptimal	Marginal
3. Velocity/ Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).	Only 3 of the 4 regimes present (if fast-shallow is missing score lower). If slow-deep missing score 15.	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).
SCORE	20 19 18 17 16	<u>15</u> 14 13 12 11	10 9 8 7 6
Comments			
	Optimal	Suboptimal	Marginal
4. Sediment Deposition	Sediment deposition affects less than 5% of stream bottom in quiet areas. New deposition on islands and point bars is absent or minimal.	Sediment deposition affects 5-30% of stream bottom. Slight deposition in pool or slow areas. Some new deposition on islands and point bars. Move to marginal if build-up approaches 30%.	Sediment deposition affects 30-50% of stream bottom. Sediment deposits at obstruction, constrictions and bends. Moderate pool deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6
Comments			
	Optimal	Suboptimal	Marginal
5. Channel Flow Status.	Water reaches base of both lower banks and streambed is covered by water throughout reach. Minimal productive habitat is exposed.	Water covers > 75% of streambed or 25% of productive habitat is exposed.	Water covers 25-75% of streambed and/or productive habitat is mostly exposed.
SCORE	20 19 18 17 16	15 14 <u>13</u> 12 11	10 9 8 7 6
Comments			

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (BACK)

Station ID <u>HNDG600-5 PU</u>		Date <u>4/12/17</u>		Initials <u>WLP + DSA</u>	
6. Channel Alteration	Optimal Channelization, dredging rock removal or 4-wheel activity (past or present) absent or minimal; natural meander pattern. NO artificial structures in reach. Upstream or downstream structures do not affect reach.	Suboptimal Channelization, dredging or 4-wheel activity up to 40%. Channel has stabilized. If larger reach, channelization is historic and stable. Artificial structures in or out of reach do not affect natural flow patterns.	Marginal Channelization, dredging or 4-wheel activity 40-80% (or less that has not stabilized.) Artificial structures in or out of reach may have slight affect.	Poor Over 80% of reach channelized, dredged or affected by 4-wheelers. Instream habitat greatly altered or removed. Artificial structures have greatly affected flow pattern.	
	SCORE	20 19 18 <u>17</u> 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
	Comments				
7. Frequency of re-oxygenation zones. Use frequency of riffle or bends for category. Rank by quality.	Occurrence of re-oxygenation zones relatively frequent; ratio of distance between areas divided by average stream width <7:1.	Occurrence of re-oxygenation zones infrequent; distance between areas divided by average stream width is 7 - 15.	Occasional re-oxygenation area. The distance between areas divided by average stream width is over 15 and up to 25.	Generally all flat water or flat bedrock; little opportunity for re-oxygenation. Distance between areas divided by average stream width >25.	
	SCORE	20 19 <u>18</u> 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
	Comments				
8. Bank Stability (score each bank) Determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. If approaching 30% score marginal if banks steep.	Moderately unstable; 30-60 % of bank in reach has areas of erosion; high erosion potential during floods. If approaching 60% score poor if banks steep.	Unstable; many eroded area; raw areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.	
	SCORE (LB)	Left Bank 10 9	8 7 6	5 4 <u>3</u>	2 1 0
	SCORE (RB)	Right Bank 10 9	8 7 6	5 4 <u>3</u>	2 1 0
Comments					
9. Vegetative Protective (score each bank) includes vegetation from top of bank to base of bank. Determine left or right side by facing downstream	More than 90% of the bank covered by undisturbed vegetation. All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally. All plants are native.	70-90% of the bank covered by undisturbed vegetation. One class may not be well represented. Disruption evident but not effecting full plant growth. Non-natives are rare (< 30%)	50-70% of the bank covered by undisturbed vegetation. Two classes of vegetation may not be well represented. Non-native vegetation may be common (30-50%).	Less than 50% of the bank covered by undisturbed vegetation or more than 2 classes are not well represented or most vegetation has been cropped. Non-native vegetation may dominate (> 50%)	
	SCORE (LB)	Left Bank 10 9	8 7 6	5 <u>4</u> 3	2 1 0
	SCORE (RB)	Right Bank 10 9	8 7 6	<u>5</u> 4 3	2 1 0
Comments					
10. Riparian Vegetative Zone Width (score each bank.) Zone begins at top of bank.	Average width of riparian zone > 18 meters. Unpaved footpaths may score 9 if run-off potential is negligible.	Average width of riparian zone 12-18 meters. Score high if areas < 18 meters are small or are minimally disturbed.	Average width of riparian zone 6-11 meters. Score high if areas less than 12 meters are small or are minimally disturbed.	Average width of riparian zone <6 meters. Score high if areas less than 6 meters are small or are minimally disturbed.	
	SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 <u>1</u> 0
	SCORE (RB)	Right Bank 10 9	8 7 <u>6</u>	5 4 3	2 1 0
Comments					

Total Score 136.5

Comparison to Ecoregion Guidelines (circle): ABOVE or BELOW

If score is below guidelines , result of (circle): Natural Conditions or Human Disturbance

Describe